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DISTRIBUTION, ABUNDANCE, AND HABITAT AFFINITIES OF THE COASTAL PLAIN SWAMP SPARROW

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ABSTRACT.—We examined the distribution and abundance of the Coastal Plain Swamp Sparrow (*Melospiza georgiana nigrescens*) at previously occupied sites and points within potential habitat. We found Swamp Sparrows throughout their formerly documented range except in southern Chesapeake Bay. Swamp Sparrows were most common in the Mullica River region of New Jersey where we detected individuals at 78% of systematically chosen points with a mean count of 4.1 birds/point. The percentages of points with positive detections in the regions of Delaware River (39%), eastern Delaware Bay (23%), western Delaware Bay (34%), and Tuckahoe River (31%) were lower. The mean count of birds/point was between 0.4 and 0.6 in these regions. A higher resolution Poisson model of relative abundance suggested that the greatest concentrations of Swamp Sparrows occurred not only in the Mullica River area but also along northwestern Delaware Bay. Regression analysis of Swamp Sparrow counts and habitat features identified shrubs (*Iva frutescens* and *Baccharis halimifolia*) as a key habitat component. By applying density estimates generated by DISTANCE (Thomas et al. 1998) to the approximate area of potential shrub habitat along Delaware Bay, we estimated that the core population of Coastal Plain Swamp Sparrows was less than 28,000 pairs. We recommend that the Coastal Plain Swamp Sparrow be listed as a subspecies of concern by state and local governments because of its relatively small population size, restricted distribution in the mid-Atlantic region, and narrow habitat requirements. *Received 23 April 2002, accepted 13 November 2002.*

The Coastal Plain Swamp Sparrow (*Melospiza georgiana nigrescens*) is one of three subspecies of Swamp Sparrow, but unlike the more common races, *M. g. nigrescens* is restricted to a small region of the Mid-Atlantic coastal bay ecosystem. Originally described from specimens collected in the Nanticoke River marshes during 1947 (Bond and Stewart 1951), *M. g. nigrescens* occurs only in estuarine marshes of the upper Chesapeake and Delaware bays and in large river drainages along the Atlantic coast of New Jersey north to the tidal portions of the Hudson River (Greenberg and Droege 1990). Subsequent analysis has shown that *M. g. nigrescens* is morphologically distinct from all other Swamp Sparrows (Greenberg and Droege 1990). The *nigrescens* race is one of the few vertebrate subspecies endemic to the mid-Atlantic region, but investigations into its biology and status are lacking.

Within mid-Atlantic estuaries, Swamp Sparrows (*M. g. nigrescens* unless otherwise noted) are restricted to an often narrow band of shrubby habitat at the interface of upland and high marsh. This habitat is particularly susceptible to recent changes such as rising sea level, ditching, impoundment, the invasion of the reed *Phragmites australis*, and the development of roads, farm fields, and housing tracts. Studies conducted during the late 1980s identified breeding populations of up to 70 singing males at several sites in the upper Chesapeake Bay (RG unpubl. data). Subsequent visits to these and other sites with formerly documented breeding populations revealed marked reductions of Swamp Sparrow numbers in Maryland. Given significant declines of similar marsh-nesting subspecies, including the Cape Sable Seaside-Sparrow (*Ammodramus mirabilis*; Pimm et al. 1996), Dusky Seaside-Sparrow (*A. nigrescens*; Sykes 1980), and San Francisco Bay Song Sparrow (*Melospiza melodia* spp.; Marshall and Dedrick 1994), we undertook a standardized survey of the Chesapeake and Delaware bays to examine the current status of Coastal Plain Swamp Sparrows. We surveyed previously occupied sites and sites within potential

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breeding habitat to evaluate range changes, characterize habitat associations, identify regions of potential management importance, and generate baseline population estimates.

METHODS

Range prior to 2000.—We obtained records from the Breeding Bird Survey (1966–1999; Patuxent Wildlife Research Center, PWRC), state Breeding Bird Atlases (Delaware, 1983–1987; Maryland, 1983–1987; New Jersey, 1993–1997), published reports (Harlow 1907, Stone 1937, Stewart and Robbins 1958, Moore 1989, West 1993, Clapp 1997, McCann and Battin 1999, Hess et al. 2000), Maryland miniroute data, migration cards, nest records, stomach content cards (data at PWRC), specimen records (Univ. of California, Berkeley), and amateur birders throughout the study area (see acknowledgments). We considered only records from the coastal plain between 15 May and 31 August in order to avoid taxonomic confusion between *M. g. nigrescens* and migrants of other Swamp Sparrow races (Mowbray 1997). We surveyed sites previously occupied by Swamp Sparrows in order to characterize their current range more completely, but we did not include these data in regional comparisons.

Survey design.—We surveyed six distinct physiogeographic regions (Chesapeake Bay, Delaware River, western Delaware Bay, eastern Delaware Bay, Tuckahoe River, and Mullica River). We excluded regions in northern New Jersey and the Piedmont west of Chesapeake Bay because morphological characters of birds in these areas fall between those of *M. g. nigrescens* and *M. g. georgiana* (Greenberg and Droege 1990; RG unpubl. data). We also excluded marshes within Blackwater National Wildlife Refuge (NWR) and the remainder of southeastern Chesapeake Bay because at the time of this study few records existed for this region and the vast marshes would have been over represented in our sampling.

We identified potential marsh habitat along Chesapeake Bay and its major tributaries using USGS 1:24,000 topographical maps. We randomly allocated survey effort to these marsh sites proportionate to their area. To ensure adequate coverage of northern Chesapeake Bay, which has numerous and continuous records of Swamp Sparrows, we constrained our sampling by surveying 60 marsh sites north of Annapolis and 60 to the south. Of these, only 70 were accessible. We followed a similar method to identify 18 marsh sites along the Delaware River from Wilmington to Philadelphia.

Swamp Sparrow habitat use is poorly documented. When possible, surveyors located a point within shrubby brackish habitat (Greenberg and Droege 1990) at each marsh site in order to maximize the chance of detecting a Swamp Sparrow. In cases where sites were in close proximity, surveyors located points ≥400 m apart to prevent counting birds twice.

Along the shores of Delaware Bay, coastal marsh forms a continuous band of potential habitat. Therefore, in this area, we systematically assigned points at 400-m intervals along all roads traversing marsh habitat. Droege (1990) discussed the validity of extrapolating data from roadside surveys, but in our experience, roads in coastal marsh were similar to dikes or upland barriers, which were common in the managed wetlands surveyed. Along the western shore of Delaware Bay, we surveyed all accessible roadside points (n = 176) between Lewes and Delaware City. Along eastern Delaware Bay, we surveyed every other point from the Delaware Memorial Bridge east to the confluence of the Mullica and Wading rivers. Because of the geographical isolation of points in the Tuckahoe River (n = 16) and Mullica River (n = 9) areas, we considered these regions to be distinct from the eastern shore of Delaware Bay (n = 106 points). We did not survey the extensive marshes along the Atlantic Coast because prior records do not exist for this region and spot checking revealed no evidence of Swamp Sparrows.

Point counts.—We performed a single 10-min count at each point between 05:00 and 10:00 EST during periods of low wind (<29 kph) and no rain. We preferred wider sampling to replication since this is a more efficient means of reducing total variability in index surveys (Link et al. 1994). We conducted the survey between 25 May and 7 July 2000, the approximate period of peak singing (RG unpubl. data). Although singing decreased as pairs began nesting, behaviors associated with nesting (e.g., chipping and mobbing) helped maintain detectability. We mapped all Swamp

Sparrows detected within a 100-m radius, recorded substrate use when detected visually, and determined sex based on crown pattern and behavioral cues (Greenberg 1988). We used detections of Swamp Sparrows outside of the circle and outside of standard count periods in order to establish a more complete geographical range, but we excluded these observations from density estimates and comparisons of relative abundance. At each survey point, we estimated the percent area within a 100-m radius circle described by each of eight habitat categories: nonmarsh, open water, mudflat-beach, shrub, *Phragmites*, rush-reed-grass >0.5 m, rush-reed-grass <0.5 m, and other. Nonmarsh included forest, paved or gravel surfaces of roads, and farm fields. Other included broad-leaved emergent plants such as arrow arum (*Peltandra virginica*), pickerelweed (*Pontederia cordata*), and spatterdock (*Nuphar luteum*). We distinguished *Phragmites* from other reeds because it is structurally distinct (taller) and it is an invasive species whose presence has been implicated in the decline of other marsh species (Benoit and Askins 1999). Distinguishing between reeds and grasses of different heights served to grossly differentiate marshes dominated by short species such as salt-meadow grass (*Spartina patens*) and the short form of smooth cordgrass (*S. alterniflora*) from marshes dominated by taller species such as the tall form of smooth cordgrass.

Density.—We estimated density of Swamp Sparrows within the continuous band of habitat along Delaware Bay using DISTANCE (Thomas et al. 1998). Variance in counts between points in other regions was too high to make meaningful predictions. DISTANCE models detection probability as a function of distance between bird and observer, thereby accounting for potential decreases in detection efficiency with increasing distance from the observer. This approach assumes that detection is perfect within the smallest distance interval. We grouped observations into 20-m intervals to reduce the effects of error associated with observers' distance estimates. We used only detections of adult male birds within a 100-m circular plot to generate models for the eastern and western shores of Delaware Bay. The best model, selected using Akaike's Information Criterion (Akaike 1973), incorporated a uniform key function plus a cosine series expansion (Buckland et al. 1993).

Statistical methods.—We used SYSTAT 7.0 (SPSS 1997) to perform tests on data from randomly and systematically chosen points. Because of the nonnormal distribution of the data, we used the nonparametric Kruskal-Wallis test to judge regional differences in mean counts of birds. Differences were deemed significant if $P < 0.05$. We modeled the relationship between Swamp Sparrow counts and habitat variables using Poisson regression (Vincent and Haworth 1983), which is a special case of the General Linearized Model (McCullagh and Nelder 1989). We removed the covariate "other" from the model because habitat variables are compositional (i.e., the sum of fractional areas devoted to each habitat character is equal to one).

We created a map of relative abundance using a Poisson model with a spatially correlated random effect as described by Royle et al. (2001). Under this model, the correlation between expected count at any two sites decreases as an exponential function of distance between those sites. Relative abundance on the map represents the expected mean count that one would observe at a given location if suitable habitat exists.

RESULTS

Distribution.—The current distribution of Swamp Sparrows matches the distribution of past breeding season records except for the absence of birds along southern Chesapeake Bay. Swamp Sparrows occurred along the shores of Delaware Bay where suitable habitat exists (Fig. 1). The population extended into marshes of the Delaware River and the large rivers along the southern Atlantic coast of New Jersey but not along the Atlantic coast of Delaware.

We detected Swamp Sparrows at 78% of points ($n = 9$) in the Mullica River drainage and this rate of detection was significantly higher than in any other region (Table 1; $H = 18.043$, $P = 0.001$). No significant differences existed among other regions (Table 1). We did not include the Chesapeake Bay region in this test because some randomly chosen marsh sites included little or no habitat even though USGS maps indicated otherwise. Detection of Swamp Sparrows in this region was low (7%,

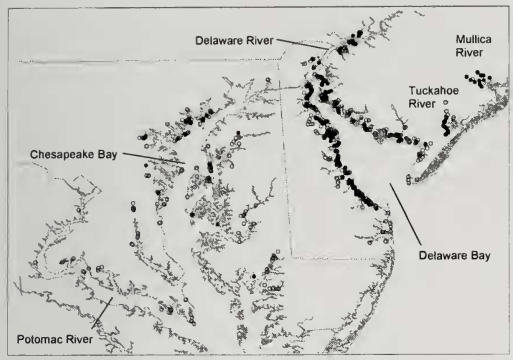

FIG. 1. Distribution of Coastal Plain Swamp Sparrows observed in 2000. Closed circles represent all records of Swamp Sparrows generated during point counts or otherwise. Open circles represent sites (randomly chosen or previously occupied) at which Swamp Sparrows were not detected during a 10-min point count.

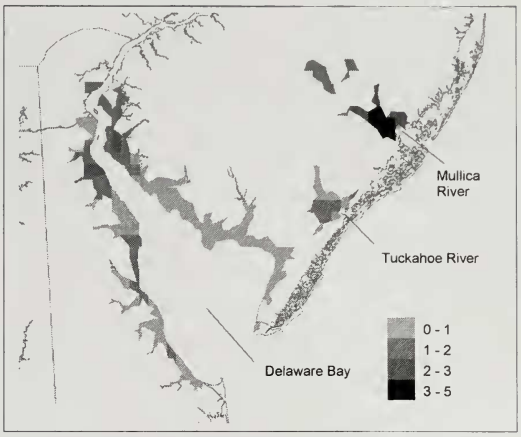

FIG. 2. Relative abundance of Coastal Plain Swamp Sparrows showing concentrated populations in the Mullica River region and northwest Delaware Bay. Shading corresponds to the number of males predicted to be detected during a 10-min point count in the major regions of estuarine emergent and shrub-scrub wetlands and palustrine emergent and shrub-scrub wetlands (National Wetlands Inventory; www.nwi.fws.gov).

0.1 birds/point, $n = 70$; Table 1). We located only 8 Swamp Sparrows in Chesapeake Bay during random surveys and we found only 4 by any means south of Annapolis.

Given the lack of specific habitat preference information for Swamp Sparrows, surveyors may not have conducted point counts in appropriate locations. Therefore, a regional comparison of Swamp Sparrow counts at points where at least one Swamp Sparrow was detected (i.e., occupied points) may be a better indicator of regional differences in distribution. Mean counts of birds at occupied points along the Mullica River (5.3 ± 1.6 SE) were significantly higher than in all other regions ($H = 15.214$, $P = 0.004$; Table 1). No significant differences existed among other regions.

A higher resolution map of relative abundance generated by a Poisson model of predicted counts revealed that areas of greater abundance extended farther to the mouth of Delaware Bay along the western shore compared to the eastern shore (Fig. 2). In addition, this model indicated that regions of high abundance occurred not only in the Mullica River area but also in the northwestern portion of Delaware Bay between Taylor's Bridge, Delaware, and Salem, New Jersey.

Habitat affinity.—Counts of Swamp Sparrows were significantly higher at plots with a greater proportion of shrub ($Z = 3.460$, $P < 0.001$; Table 2). The presence of open water

TABLE 1. Indices of abundance of Coastal Plain Swamp Sparrows based on 10-min, 100-m radius point counts performed in 2000. Counts and detection frequencies within the Mullica River region were significantly greater than in all other regions.

	All points				Points with at least one positive detection	
Region	*n*	% Points with positive detection	Maximum count	Mean count (± SE)	*n*	Mean count (± SE)
Chesapeake Bay	70	7	3	0.1 ± 0.1	5	1.6 ± 0.8
Delaware Bay (east)	106	23	5	0.5 ± 0.1	24	2.2 ± 0.5
Delaware Bay (west)	176	34	5	0.6 ± 0.1	60	1.7 ± 0.2
Delaware River	18	39	3	0.6 ± 0.2	7	1.6 ± 0.6
Mullica River	9	78	11	4.1 ± 1.3	7	5.3 ± 1.6
Tuckahoe River	16	31	2	0.4 ± 0.2	5	1.4 ± 0.6

TABLE 2. Relationship between counts of Coastal Plain Swamp Sparrows and habitat features as determined by a Poisson regression model. Swamp Sparrows were positively associated with shrubs, most commonly marsh-elder and saltbush.

Habitat feature	*Z*	*P*
Nonmarsh	−1.388	0.165
Water	−2.080	0.038
Beach-mudflats	0.244	0.807
Shrub	3.460	0.001
Phragmites	0.981	0.327
Reed-rush-grass < 0.5 m tall	−1.202	0.230
Reed-rush-grass > 0.5 m tall	0.220	0.826

correlated negatively ($Z = -2.080$, $P = 0.038$). The percentage of *Phragmites* in count circles correlated positively with Swamp Sparrow abundance, but not significantly (Table 2). Visual detections of Swamp Sparrows confirmed these habitat associations. Of 42 Swamp Sparrows observed directly, 33 were found in shrubs and eight in dead or living *Phragmites*.

Regional density and population estimate.—We estimated the density of male Swamp Sparrows along the eastern and western shores of Delaware Bay to be about 16/km^2 (95% CI = 10–23/km^2) and 37/km^2 (95% CI = 27–53/km^2), respectively. We generated these density estimates from plots where the mean percentage of unavailable habitat (roads, agricultural fields, forest) was about 20%. According to National Wetlands Inventory definitions (NWI; www.nwi.fws.gov), Swamp Sparrow habitat falls within four subclasses: estuarine persistent emergent, estuarine broad-leafed deciduous shrub-scrub, palustrine persistent emergent, and palustrine broad-leafed deciduous shrub-scrub. To generate a gross estimate of the core Swamp Sparrow population, we summed the area of wetlands of these four categories along the eastern and western shores of Delaware Bay (approximately 342 km^2 and 375 km^2 respectively; NWI) and multiplied by the density estimates above. This yielded a population estimate of 28,000 pairs, assuming a strong correlation between singing males and nesting females (Greenberg 2003).

DISCUSSION

We found the Coastal Plain Swamp Sparrow throughout its documented range, except along the southern Chesapeake Bay. We did not detect Swamp Sparrows along the Potomac River or the Patuxent River where birds had been observed only sporadically throughout the 1980s and 1990s. Similarly, we found little evidence of Swamp Sparrows at former breeding sites along the eastern shore of Chesapeake Bay, including the extensive Nanticoke marshes from which the type specimen originally was described. In contrast, breeding season records indicated continual occupancy along northwestern Chesapeake Bay since at least 1978. Within this region, we found small populations of Swamp Sparrows within the Patapsco River marshes south of Baltimore, in the area of Black Marsh and Hart-Miller Island, and in two locations on the Aberdeen Proving Ground. We found no evidence of large populations such as that observed by RG (unpubl. data) at Black Marsh during the 1970s.

We found several populations of Swamp Sparrows along the Delaware River, and a census of the John Heinz NWR at Tinicum revealed 22 pairs. Harlow, observing Swamp Sparrows near Philadelphia in the early 1900s, stated that "this species is the most abundant bird and nests in incredible numbers" (1907: 122). It is unlikely that our numbers reflect those described in Harlow's accounts.

Swamp Sparrows appeared to be most concentrated along the shores of Delaware Bay. Along the western shore, they occurred almost continuously from Lewes to Delaware City. The estimated density of 37 males/km^2 in this region, however, was low compared to 37–100 pairs/km^2 found during 1986 at Ted Harvey WMA (Moore 1989) and 125 territories/km^2 found during 1975 at Prime Hook NWR (West 1993). A Delaware Natural Heritage study at Woodland Beach found 189 territories/km^2 during 2000 (C. Heckscher pers. comm.). This disparity in density estimates probably is attributable to patchily distributed habitat and not fluctuating population sizes. We found Swamp Sparrows less frequently on the eastern shore of Delaware Bay (15 males/km^2), especially near Port Norris where previous occupation was well documented. On the other hand, we found high concentrations of Swamp Sparrows in the Mullica River for which we had no prior records of occupancy.

We observed Swamp Sparrows most com-

monly at the upland edges of marsh using marsh-elder (*Iva frutescens*) and saltbush (*Baccharis halimifolia*). We also found Swamp Sparrows in buttonbush (*Cephalanthus occidentalis*), red maple (*Acer rubrum*), and mallow (*Hibiscus* sp.) Dikes and roads traversing low marsh sometimes provided shrub habitat that may not have existed otherwise. In a few cases, we found Swamp Sparrows using wet fields adjacent to fresh or brackish tidal marsh. Plant species from these fields included switch grass (*Panicum virgatum*), plumegrass (*Erianthus giganteus*), sedges (*Carex* spp.), and beakrush (*Rhynchospora* sp.). A positive, but insignificant, correlation existed between Swamp Sparrows and *Phragmites*, a reed which forms dense, monotypic stands throughout coastal plain marshes. Male birds often used stalks as song posts and individuals sometimes foraged at the base of dead stalks.

Extensive, large tracts of Delaware Bay marsh are dominated by the short form of smooth cordgrass and salt-meadow grass. Though not significant, Swamp Sparrow counts correlated negatively with these short reed-rush-grasses. Canoe surveys throughout the low interior of marshes at Bombay Hook NWR and Mad Horse Wildlife Management Area corroborated this negative correlation (SD unpubl. data). Observations in the field suggested that the actual zone of suitable shrub habitat available to Swamp Sparrows typically extended only 200–400 m from the edge of the marsh-upland transition. Thus, our population estimate, which is derived from habitat estimates that include low marsh, probably is biased high.

We found only 34 Swamp Sparrows within the Chesapeake Bay region; however, subsequent searching indicates that several small populations exist in the Blackwater NWR (P. Marra pers. comm.). The extent to which the population penetrates the Pine Barrens (New Jersey) or extends north toward the Hudson River is undocumented at this time, but RG (unpubl. data) observed very few in Hudson Estuary tidal marshes. It currently is impossible to produce a rigorous global estimate of the Swamp Sparrow population. However, if we double our estimate of 28,000 (for the core Delaware Bay population) to 56,000 pairs to account for peripheral populations in the Chesapeake and northern New Jersey, then the Coastal Plain Swamp Sparrow population is on the same order of magnitude as that of the San Francisco region Song Sparrows (Marshall and Dedrick 1994), which have been designated federal subspecies of special concern.

Swamp Sparrows occupy a narrow band of vulnerable habitat within a limited geographic area. Coastal wetlands in the states of Maryland, Delaware, and New Jersey have declined by approximately 50% since the late 1700s (Dahl 1990) and development pressures will result in future habitat loss. In addition, the Environmental Protection Agency predicts a 50% chance that sea level will rise 58 cm at Lewes, Delaware, by 2100 (Environmental Protection Agency 1997). Rising water levels will inundate coastal wetlands and may threaten currently preserved habitat. A listing of the Coastal Plain Swamp Sparrow with other species of concern would facilitate the development of research and management initiatives before the subspecies reaches threatened or endangered status.

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